Pakistan J. Agric. Res. Vol. 9, No. 4, 1988

GRAIN QUALITY CHARACTERISTICS OF PAKISTANI COMMERCIAL RICE VARIETIES

M. Aslam Sagar, M. Ashraf and M. Akmal Khan*

ABSTRACT:- The physicochemical characteristics of aromatic and non-aromatic commercial rice varieties grown in Pakistan were studied. Highest values for length (7.3 mm) and elongation ratio (2.1) were recorded in 'Basmati-6129', whereas lowest values of 5.8 mm and 1.3 for the same quality traits were observed in 'JP-5'. Protein content (PC) ranged from 6.5 to 8.7% and from 6.4 to 8.6% in aromatic and non-aromatic rices, respectively. Classification on the basis of amylose content (AC), gel consistency, alkali spreading value (AS) and gelatinization temperature (GT) were made. 'Lateefy', 'DR-82' and 'JP-5' showed different quality trends in their respective groups. 'IR-8' was the hardest (35 mm) while 'DR-82' had the softest (82 mm) gel consistency. Significant negative correlations between GT and PC, between GT and AS and between AC and AS were observed. Strong aroma was perceived in 'Basmati-370'.

Key Words: Rice; Varieties; Chemicophysical Properties; Statistical Analysis; Pakistan.

INTRODUCTION

Pakistan is blessed with multitude of agro-climatic conditions for growing several types of rice i.e., aromatic long fine grain, medium grain and round grain japonica type. One third of total production (3.4 mt) is annually exported and two third is locally consumed to meet food needs. Aromatic rice has a special place in world rice markets. 'Basmati-370' is the leading aromatic rice in world trade for its distinct aroma and excellent cooking and eating quality and so fetches a price three to four times higher than that of normal long grain rices. About five percent of world total production moves into international market showing that world rice market is very thin. Therefore, a small change in quality can have a major impact on supply and/or demand and on prices. Therefore, future market is for quality rice. Coupled with production, harvesting and postharvest operations, variety is considered the most important determinant of market quality. Presently a large number of rice varieties are grown in different rice growing zones of Pakistan and our breeding programmes are continually striving to refine and improve the genetic characteristics that influence quality to tailor the most desirable varieties for local, as well as, foreign markets.

Rice varieties have been classified on the basis of a) size and shape (Khush et al., 1979) b) amylose content (Juliano, 1971) and c) gel consistency (Cagampang et al., 1973). Improvement of aroma in Basmati during aging has been reported by Jilani (1985). Correlation coefficient among different rice quality parameters have been reported by Juliano et al. (1980).

The present study was undertaken to report the physicochemical properties of some commercial rice varieties of Pakistan grown in different regions to provide benchmark information for breeders, administrators, policy makers and all other segments involved in rice industry.

MATERIALS AND METHODS

Twelve paddy samples of commercial rice varieties obtained from experimental plots grown at Rice Research Institute, Kala Shah Kaku, Lahore and Rice Research Institute, Dokri during 1983-85 were dried upto 14% moisture content. Samples were divided into aromatic ('Basmati-370', 'Basmati-6129', Basmati-198', 'Kashmir Basmati', 'Lateefy'

* National Agricultural Research Centre, Islamabad.

Pakistan J. Agric. Res. Vol. 9, No. 4, 1988

GRAIN QUALITY CHARACTERISTICS OF PAKISTANI COMMERCIAL RICE VARIETIES

M. Aslam Sagar, M. Ashraf and M. Akmal Khan*

ABSTRACT:- The physicochemical characteristics of aromatic and non-aromatic commercial rice varieties grown in Pakistan were studied. Highest values for length (7.3 mm) and elongation ratio (2.1) were recorded in 'Basmati-6129', whereas lowest values of 5.8 mm and 1.3 for the same quality traits were observed in 'JP-5'. Protein content (PC) ranged from 6.5 to 8.7% and from 6.4 to 8.6% in aromatic and non-aromatic rices, respectively. Classification on the basis of amylose content (AC), gel consistency, alkali spreading value (AS) and gelatinization temperature (GT) were made. 'Lateefy', 'DR-82' and 'JP-5' showed different quality trends in their respective groups. 'IR-8' was the hardest (35 mm) while 'DR-82' had the softest (82 mm) gel consistency. Significant negative correlations between GT and PC, between GT and AS and between AC and AS were observed. Strong aroma was perceived in 'Basmati-370'.

Key Words: Rice; Varieties; Chemicophysical Properties; Statistical Analysis; Pakistan.

INTRODUCTION

Pakistan is blessed with multitude of agro-climatic conditions for growing several types of rice i.e., aromatic long fine grain, medium grain and round grain japonica type. One third of total production (3.4 mt) is annually exported and two third is locally consumed to meet food needs. Aromatic rice has a special place in world rice markets. 'Basmati-370' is the leading aromatic rice in world trade for its distinct aroma and excellent cooking and eating quality and so fetches a price three to four times higher than that of normal long grain rices. About five percent of world total production moves into international market showing that world rice market is very thin. Therefore, a small change in quality can have a major impact on supply and/or demand and on prices. Therefore, future market is for quality rice. Coupled with production, harvesting and postharvest operations, variety is considered the most important determinant of market quality. Presently a large number of rice varieties are grown in different rice growing zones of Pakistan and our breeding programmes are continually striving to refine and improve the genetic characteristics that influence quality to tailor the most desirable varieties for local, as well as, foreign markets.

Rice varieties have been classified on the basis of a) size and shape (Khush et al., 1979) b) amylose content (Juliano, 1971) and c) gel consistency (Cagampang et al., 1973). Improvement of aroma in Basmati during aging has been reported by Jilani (1985). Correlation coefficient among different rice quality parameters have been reported by Juliano et al. (1980).

The present study was undertaken to report the physicochemical properties of some commercial rice varieties of Pakistan grown in different regions to provide bench-mark information for breeders, administrators, policy makers and all other segments involved in rice industry.

MATERIALS AND METHODS

Twelve paddy samples of commercial rice varieties obtained from experimental plots grown at Rice Research Institute, Kala Shah Kaku, Lahore and Rice Research Institute, Dokri during 1983-85 were dried upto 14% moisture content. Samples were divided into aromatic ('Basmati-370', 'Basmati-6129', Basmati-198', 'Kashmir Basmati', 'Lateefy'

* National Agricultural Research Centre, Islamabad.

and 'Basmati-385') and non-aromatic ('IR-6', 'IR-8', 'KS-282', 'DR-82', 'DR-83' and 'JP-5') types, dehulled in a Satake THU-35 dehuller and milled in a Satake TM-05 grain testing mill. Head rice flour was prepared using Udy-Cyclone mill with 60 mesh sieve and mixed thoroughly.

Length (L) of 10 randomly selected whole grains (raw and cooked) and breadth (B) of raw rice was determined by photo-enlarger (10 x). The mean of L, B and L/B ratio was computed. The method of Azeez and Shafi (1966) was used for cooking and calculating elongation ratio.

Amylose content was determined according to modified method of Juliano (1971). Kjeldahl method was used for N estimation and protein was determined by multiplying N with a factor of 5.95. Alkali spreading value, gel consistency and gelatinization temperature were determined by techniques described by Little et al. (1958), Cagampang et al. (1973) and Juliano (1974), respectively. The aroma was evaluated according to method used at IRRI (1970).

RESULTS AND DISCUSSION

The length (L), breadth (B) and L/B ratio of raw and L of cooked rice and elongation ratio varied from 6.2 to 7.3 mm, 1.6 to 1.8 mm, 3.7 to 4.6, 11.0 to 15.1 mm and 1.8 to 2.1 in aromatic types and 5.8 to 7.0 mm, 1.6 to 3.0 mm, 1.9 to 4.0, 7.8 to 14.2 mm and 1.3 to 2.0 in non-aromatic types, respectively, (Tables 1 and 2). 'Basmati-6129' had the maximum length (7.3 mm) and elongation ratio (2.1) whereas minimum length (5.8 mm), maximum breadth (3.0 mm) and lowest elongation ratio (1.3) were found in 'JP-5'. The data indicated that there was 100% increase in elongation ratio in aromatic types which was considered a highly desirable trait of high quality. Grain size and shape were determined on the basis of L and L/B. All the aromatic type grains were long and slender except 'Lateefy' which had medium size grain. The non-aromatic varieties had medium to long and slender grains except 'IR-8' and 'JP-5' which had medium and bold shape, respectively. These findings are in line with Khush et al. (1979).

Amylose and protein contents are two of the most important determinant of grain quality in rice. Amylose content ranged from 20.00 to 27.70% with a mean of 22.10% and 21.62 to 29.69% with a mean of 26.48% in aromatic and non-aromatic rice grains, respectively. None of the varieties had a low amylose content (< 20%). 'Lateefy', 'DR-83' and 'JP-5' showed opposite trend for amylose content in their particular groups. On amylose content basis varieties were classified as intermediate and high amylose. This trend substantiates the findings of Juliano (1976). Among the different environmental factors affecting amylose content, temperature during grain ripening is the dominant factor, followed by nitrogen fertilization and the degree of milling.

No significant difference in protein content was observed in both types of rice. However, 'JP-5' (6.4%) and 'Kashmir Basmati' (6.5%) had the lowest values in their respective groups. The protein content from 4.3 to 18.2% in IRRI's world collection has been reported (Gomez, 1979). Cropping season, management and cultural practices are largely responsible for variations in the level of protein content.

Alkali spreading values for aromatic and non-aromatic types varied from 5.0 to 7.0 and from 6.4 to 7.0, respectively. Both types of grains fell under low, intermediate/low and intermediate final gelatinization temperature as the values were in the range of 6—7, 3.5—5.9 and 4—5, respectively. 'Lateefy' exhibited the highest (7.0) and 'DR-83' the lowest (4.6) alkali spreading value showing different behaviour in their groups which may be attributed to amylose content. 'DR-82' (5.1), 'Basmati-198' (6.8) and 'Basmati-385'

Table 1. Physicochemical dimensions of aromatic rice varieties

Variety	Length (mm)	Breadth (mm)	L/B Ratio	Size	Shape	Length (cooked grain) (mm)	Elongation ratio	Amylose (%db)	Protein% (12.5% moisture)	Alkali spreading value (1.7% KOH)	*Gel consistency (mm)	Gelatinization temperature (°C) (Photometeric)	Aroma
'Basmati-370'	6.6	1.6	4.1	Long	Slender	13.2	2.0	20.00	8.3	5.3 (I/L)	53 (M)	70.0	S
'Basmati-6129'	7.3	1.6	4.6	Long	Slender	15.1	2.1	20.84	8.7	5.9 (I/L)	54 (M)	65.0	MS
'Basmati-198'	6.6	1.7	3.9	Long	Slender	12.4	1.9	20.69	7.3	6.8 (L)	55 (M)	67.0	MS
'Kashmir Basmati'	6.6	1.8	3.7	Long	Slender	12.2	1.8	20.15	6.5	5.0 (I)	60 (M)	71.5	MS
'Lateefy'	6.2	1.6	3.9	Medium	Slender	11.0	1.8	27.70	8.6	7.0 (L)	58 (M)	64.5	W
'Basmati-385'	6.6	1.8	3.7	Long	Slender	12.5	1.9	23.18	8.6	6.1 (L)	58 (M)	65.0	MS
Range	6.2 – 7.3	1.6 – 1.8	3.7 - 4.6			11.0 – 15.1	1.8 – 2.1	20.00 – 27.70	6.5–8.7	5.0–7.0	53–60	64.5–71.5	–
X	6.7	1.7	4.0			12.7	1.9	22.10	8.0	6.0	56.3	67.2	–
SD	0.356	0.098	0.337			1.362	0.117	2.977	0.899	0.794	2.733	2.944	–
SE	0.146	0.040	0.138			0.550	0.048	1.216	0.367	0.324	1.116	1.202	–
CV	5.313	5.783	8.429			10.723	6.153	13.471	11.236	13.225	4.853	4.381	–

Average of two determinations

****Average of 100 mg and 80 mg samples.***

L = Low, I = Intermediate GT based on alkali spreading.

M= Medium gel consistency.

S = Strong, MS = Moderately strong and W = weak.

Table 2. Physicochemical dimensions of non-aromatic rice varieties

Variety	Length (mm)	Breadth (mm)	L/B Ratio	Size	Shape	Length (cooked grain) (mm)	Elongation ratio	Amylose (%db)	Protein% (12.5% moisture)	Alkali spreading value (1.7% KOH)	*Gel consistency (mm)	Gelatinization temperature (°C) (Photometeric)
'IR-6'	6.9	1.9	3.7	Long	Slender	13.0	1.9	29.69	7.9	7.0 (L)	58 (M)	66.0
'IR-8'	6.3	2.3	2.8	Medium	Medium	10.7	1.7	28.66	7.1	7.0 (L)	35 (H)	67.5
'KS-282'	7.0	2.0	3.5	Long	Slender	14.2	2.0	28.05	8.3	7.0 (L)	47 (M)	65.5
'DR-82'	6.4	1.6	4.0	Medium	Slender	9.9	1.5	28.18	8.5	5.1 (I)	82 (S)	74.0
'DR-83'	6.8	1.9	3.7	Long	Slender	10.1	1.5	21.62	8.6	4.6 (I)	61 (S)	75.0
'JP-5'	5.8	3.0	1.9	Medium	Bold	7.8	1.3	22.70	6.4	6.0 (L)	67 (S)	64.0
Range	5.8–7.0	1.6–3.0	1.9–4.0	–	–	7.8–14.2	1.3–2.0	21.62–29.69	6.4–8.6	4.6–7.0	35–82	64.0–75.0
X	6.5	2.1	3.3	–	–	11.0	1.7	26.48	7.8	6.1	58	68.7
SD	0.455	0.488	0.781	–	–	2.305	0.266	3.415	0.876	1.067	16.219	4.665
SE	0.186	0.199	0.319	–	–	0.941	0.109	1.395	0.358	0.436	6.623	1.905
CV	6.994	23.215	23.680	–	–	23.958	15.674	12.897	11.235	17.485	27.964	6.791

Average of two determinations
**Average of 100 mg and 80 mg samples*
L = Low, I = Intermediate GT based on alkali spreading.
M = Medium, H = Hard and S = Soft gel consistency.

(6.1) also showed opposite trend presumably due to genetic variability. These observations are in line with earlier studies of Little et al. (1958). The values of alkali spreading, being indirect method of measuring gelatinization temperature coincided with gelatinization temperature values determined by photometeric method.

Gel consistency differed widely from 53 to 60 mm and from 35 to 82 mm in aromatic and non-aromatic rices, respectively. 'IR-8' had the lowest gel consistency value (35 mm) which may be due to its characteristic hard gel nature. On gel consistency basis all varieties were grouped into soft, medium and hard. All aromatic types fell in medium gel consistency class while variations existed in non-aromatic. This classification agrees with the classification reported by Cagampang et al. (1973).

The gelatinization temperature in aromatic rices ranged from 64.5 to 71.5^{o}C and in non-aromatic from 64.0 to 75.0^{o}C. Like previous quality attributes, varieties were also divided into low and intermediate gelatinization temperature rices. These findings further support IRRI (1979) scale for rice classification on gelatinization temperature basis.

In aromatic varieties, strong aroma in 'Basmati-370', weak in 'Lateefy' and moderately strong in the rest of the varieties was perceived. Associated with many organic volatile compounds, 2-acetyl-1-pyrroline was probably considered the most active component of aroma due to its characteristic pop corn like odour. The complex nature of aroma needs further experimentation. However, sensory evaluation of aroma supports the quantitative and qualitative analysis reported by Yajimia et al. (1978), Buttery et al. (1983) and Jilani (1985).

Some linear correlation coefficients among some quality factors of rice grain were noted (Table 3). Significant negative correlations at 1% level were found among gelatinization temperature and protein content and gelatinization temperature and alkali spreading and at 5% level between amylose content and alkali spreading in both

Table 3. Correlation coefficeints among some physicochemical properties of rice grain

Parameters	Amylose (%db)	Protein (%)	Alkali spreading value	Gel consistency (mm)	Gelatinization temperature (^{o}C)
				+	
Amylose (% db)		0.48	0.69*	0.39	–0.66*
Protein (%)	0.15		0.37	–0.42	–0.75**
Alkali spreading value	0.67*	–0.40		–0.03	–0.80**
Gel consistency (mm)	–0.27	0.24	–0.69*		0.09
Gelatinization temperature (^{o}C)	–0.25	–0.70**	–0.83**	0.44	
			++		

** = Significant at 5% level.*
*** = Significant at 1% level.*
+ = Aromatic rices
++ = Non-aromatic rices.

types of grains. Aromatic grains showed significant negative correlation at 5% level between gelatinization temperature and alkali spreading and non-aromatic grains between alkali spreading and gel consistency at the same level while these relationships were non-significant for the same quality parameters in opposite types of grain. Protein content, alkali spreading and gel consistency exhibited non-significant correlations among themselves. The negative correlation between amylose content and gel consistency in non-aromatic grain was probably due to high amylose content and 'IR-8', the characteristically hard gel consistency type while opposite was true in aromatic grains for the same relationship. Similar trend between gel consistency and protein content in aromatic grains could be explained on the basis of protein content contributing to the viscosity of alkaline gel in the gel consistency test while different behaviour was observed in non-aromatic grains. Alkali spreading value, which endexes gelatinization temperature of starch granules, showed poorer correlation with gel consistency in aromatic and highly significant in non-aromatic grains. This may be because non-aromatic grains are high amylose. These correlations further support the findings of Juliano and Pascual (1980).

LITERATURE CITED

1. Azeez, M.A., and Shafi, M. 1966. Quality in rice. Dept. Agric. (W. Pakistan) Tech. Bull. No. 13: 23.
2. Buttery, R.G.; Ling, L.G.; Juliano, B.O. and Turnbaugh, J.G. 1983. Cooked rice aroma and 2-acetyl 1-pyrroline. J. Agric. Food Chem. 31: 823-826.
3. Cagampang, G.B.; Perez, C.M., and Juliano, B.O. 1973. A gel consistency test for eating quality of rice. J. Sci. Fd. Agric. 24: 1959-1994.
4. Gomez, K.A. 1979. Effect of environment on protein and amylose content of rice. In: Proc. Workshop on Chemical Aspects of Rice Grain Quality. Intern. Rice Res. Inst. Los Banos, Laguna, Philippines. p. 59-68.
5. International Rice Research Institute (IRRI). 1979. Annual Report, Los Banos, Philippines. p. 23-32.
6. International Rice Research Institute, (IRRI). 1970. Annual Report, Los Banos, Philippines.
7. Jilani, G. 1985. Quality improvement in basmati rice in aging process. Paper presented at the FAO Field Workshop on Rice Grading, Inspection and Analysis Lahore—Karachi (Pakistan).
8. Juliano, B.O. 1971. A simplified assay for milled rice amylose. Cereal Sci. Today, 16: 334-340.
9. Juliano, B.O. 1974. Manual Cereal Chemistry Procedures. Chemistry Department, Int. Rice. Inst. Philippines.
10. Juliano, B.O. 1976. Biochemical studies. In: Rice Postharvest Technology. Intern. Devel. Res. Centre, Ottawa, Canada. p. 13-18.
11. Juliano, B.O., and Pascual, C.G. 1980. Quality characteristics of milled rice grown in different countries. IRRI Research Paper series No. 48. Intern. Rice Res. Inst, Philippines.
12. Khush, G.S.; Paule, C.M., and De La Cruz, N.M. 1979. Rice grain quality evaluation and improvement at IRRI. In: Proc. Workshop on Chemical Aspects of Rice Grain Quality. Los Banos, Laguna, Philippines. p. 21-31.
13. Little, R.R.; Hilder, G.B., and Dawson, E.H. 1958. Differential effect of dilute alkali on 25 varieties of milled white rice. Cereal Chem. 35: 111-126.
14. Yajima, I.; Yanai,T.; Nakamura, M.; Shakakibara, H., and Habu, T. 1978. Volatile flavour components of cooked rice. Agric. Biol. Chem. 42(6): 1229-1233.